Reduction in Modifiable Osteoporosis-Related Risk Factors Among Adults in the Older Americans Nutrition Program

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The purpose of this study was to determine the prevalence of low bone mineral density, the prevalence of modifiable osteoporosis-related risk factors, and the effectiveness of a nutrition and bone health education intervention that is tailored for a multiethnic (Caucasian and African American), low-income, low-literacy elderly population. The six risk factors were low intake of eight calcium-rich foods (less than 3 servings/day), nonuse of calcium supplements, nonuse of vitamin D-containing supplements, low physical activity (less than 5 times/week and less than 150 minutes/week), one or more of four risks for falling in the home, and current tobacco use. The 71 participants were a convenience sample from the Northeast Georgia Older Americans Nutrition Program who received Title III-C or Title III-D services. Fifty-nine completed heel bone mineral density tests at baseline and osteoporosis risk assessment questionnaires both at baseline and post-intervention. At baseline, 60 percent of the adults had either osteoporosis or osteopenia, and African-American women had more osteoporosis-related risk factors than did Caucasian women. After the intervention, the number of risk factors decreased significantly by 0.8, and over half of the participants decreased at least one risk factor. Additionally, the number of participants who consumed 3 or more servings of calcium-rich foods daily or used a calcium supplement more than doubled.

Osteoporosis is a major public health threat that is largely preventable (National Institutes of Health [NIH], 2001). In the United States, 10 million people have osteoporosis, and another 18 million have osteopenia—low bone mass that increases the risk for osteoporosis (NIH, 2001). Consequences of osteoporosis include chronic pain, bone fractures, need for placement into long-term care facilities, and death (NIH, 2001).

Because of the high prevalence and debilitating consequences of osteoporosis and bone fractures, we developed an educational intervention related to nutrition and bone health that was targeted to participants in the Older Americans Nutrition Program (OANP). Formerly known as the Elderly Nutrition Program, OANP is the largest community nutrition program for older adults in the Nation, serving about 7 percent of the older population overall and about 20 percent of the poor elders (Administration on Aging, 2002; Millen, Ohls, Ponza, & McCool, 2002). This program provides nutrition education, as well as congregate and home-delivered meal services.

The educational messages in this intervention were developed from recommendations of the 2000 NIH

Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy (NIH, 2001). From a review of 2,449 references from 1995 to 1999, the panel identified several modifiable risk factors for osteoporosis and bone fractures, including smoking, a low level of physical activity, risk of falling, and low intakes of calcium and vitamin D. Further evidence that smoking and use of smokeless tobacco are risk factors was recently reviewed (Spangler, Quandt, & Bell, 2001).

Although NIH did not make a specific recommendation for physical activity and the prevention of osteoporosis and fractures, several health organizations and experts recommend 30 minutes or more physical activity most days of the week (about 30 minutes on 5 days of the week and about 150 minutes weekly) (American College of Sports Medicine, 2002; U.S. Department of Health and Human Services [DHHS], 2000; DiPietro, 2001; USDA & DHHS, 2000). The NIH panel (2001) emphasized that exercise may decrease the risk of falling. This focus on exercise is critical because most (90 percent) hip fractures are associated with a fall (Carter, Kannus, & Khan, 2001). Both the NIH (2001) and the National Osteoporosis Foundation (NOF, 2002) recommend fall-prevention techniques in the home such as: removing throw rugs, anchoring rugs with nonskid tape, installing grab bars and stair rails, and using night-lights. These types of interventions have reduced the number of falls (Plautz, Beck, Selmar, & Radetsky, 1996).

Vitamin D is unique because it can be obtained both via skin exposure to sunlight and through food or supplements. Like all other vitamins and minerals, calcium is available only through food or supplements. Although calcium- and vitamin D-rich foods (e.g., dairy products) are the preferred source of dietary calcium and vitamin D, several organizations suggest that older people may need supplements to meet their high needs for these nutrients (NAS, 1997; NIH, 2001; USDA & DHHS, 2000). The ability to synthesize vitamin D in the skin by sun exposure declines with age and is blocked by sunscreen in people regardless of their age (NAS, 1997).

The Adequate Intake (AI) level for vitamin D (600 International Units [IU] or 15 mg) for those over 70 years old is often difficult to achieve. With the exception of milk, which is fortified in the United States with 400 IU of vitamin D per quart (Institute of Medicine, 1997), very few foods contain vitamin D in significant quantities. Consequently, relying on milk alone would require 6 cups of milk per day to meet the recommendation. Perceived milk intolerance—defined as experiencing stomach ache, flatulence, or diarrhea after drinking milk—is much higher in African Americans than in Caucasians and is a significant predictor of low milk intake in older adults (Elbon, Johnson, & Fischer, 1998). The 2000 *Dietary Guidelines for Americans* states that "people who seldom eat dairy products or other rich sources of calcium need a calcium supplement" and that "older adults and people with little exposure to sunlight may need a vitamin D supplement" (USDA & DHHS, 2000).

NIH notes that the effects of most medications for osteoporosis are evaluated in conjunction with calcium and vitamin D supplements. Clinical trials confirm that increased milk consumption to 3 to 4 servings per day slows bone loss in older men and women (Heaney et al., 1999; Storm et al., 1998). Clinical trials also confirm the effectiveness of vitamin D (700 to 800 IU/day) and calcium supplements (500 to 800 mg/day) for preventing fractures in older people (Chapuy et al., 1992; Dawson-Hughes, Harris, Krall, & Dallal, 1997).

Based on a review of the literature, we have found no systematic evaluation of osteoporosis risk or health promotion programs designed to reduce that risk among OANP participants. However, others have found that nutrition education intervention results in changes in knowledge and beliefs about osteoporosis (Blalock et al., 2000), nutrition (McCamey et al., 2003), and calcium and vitamin D intakes (Rolnick , Kopher, Jackson, Fischer, & Compo, 2001).

This study investigated the prevalence of low bone mineral density (BMD) as estimated by the heel BMD test; the prevalence of modifiable osteoporosis-related risk factors; and the effectiveness of an educational intervention related to nutrition and bone health that is tailored for a multiethnic (Caucasian and African American), low-income, and low-literacy elderly population. For the purposes of this study, the primary measurable outcome was a change in these six risk factors. These include the factors identified previously by NIH.

Methods

Data and Sample

This was a convenience sample of participants from senior centers in four counties in Georgia, with no exclusion criteria. Counties were included because of interest in the project and availability of participants. Potential sample size was limited because these were small centers located in rural areas. Participants were recruited through the directors of the senior centers who helped with advertising and enrollment.

Baseline

At baseline, heel BMD, weight, and height were assessed, and participants answered nutrition and health questions (in no particular order). Heel BMD was determined with an ultrasound bone densitometer.[1] A T-score[2] was derived by comparing each participant's BMD with the optimal and peak BMD of a 30-year-old healthy adult. Each participant received a copy and an explanation of his or her BMD results (low risk, moderate risk, or high risk for osteoporosis) and was strongly encouraged to take the results to his or her healthcare provider. Because heel BMD takes 2 to 3 years to demonstrate improvement by using the ultrasound bone densitometer, it was assessed at baseline only and thus not used as an outcome measure.

Health Education Curriculum

The health education curriculum, developed and modified by five nutrition and pharmacy experts at the University of Georgia, consisted of three lessons. The first lesson covered the definition of osteoporosis, key nonmodifiable and modifiable risk factors for osteoporosis and bone fractures (including tobacco use), and balance exercises. The second lesson covered sources of calcium and vitamin D, including foods that are naturally rich in calcium, low-lactose dairy foods and use of the lactase enzyme, calcium-fortified foods, and calcium and vitamin D supplements. To encourage a possible new food source of calcium, those presenting the lessons gave participants the opportunity to taste calcium-fortified orange juice. The third lesson reviewed ways to reduce falls, as well as medications that may be beneficial for bone health.

[1]Hologic Sahara Clinical Bone Sonometer, Bedford, MA, 2000.

[2]T-score expresses the number of standard deviations from the mean score for the young adult population (Hologic, 2000).

All participants performed balance exercises from the NIH Osteoporosis and Related Bone Diseases National Resource Center at each lesson.[3]

The four messages of this educational intervention were emphasized in each lesson: (1) Talk to Your Doctor: tobacco and smoking cessation, medications, and heel BMD results; (2) Increase Sources of Calcium and Vitamin D: dietary sources, fortified foods, and dietary supplements; (3) Take Action: increase physical activity; and (4) Take Care: fall-prevention measures.

Post-Intervention

We administered a post-test about 1 month after completion of the third lesson to assess participants' behavioral changes. The questionnaire contained items that were based on past nutrition questionnaires developed for this population (Brackett, 1999; Johnson et al., 2003), as well as issues related to nonmodifiable and modifiable risk factors for osteoporosis and bone fractures (NIH, 2001). The questionnaire included items that were used to calculate a score for the modifiable osteoporosis-related risk factors score:

(1) Low intake of calcium-rich foods—consuming less than 3 servings of eight calcium-rich foods[4]/day.

[3]The lesson plans are available on the Nutrition for Older Adults' Health Website: www.arches.uga.edu/~noahnet. The free, downloadable lesson plans consist of text and script for the lessons, handouts, materials for overhead transparencies, pre- and post-tests, as well as references for additional reading about nutrition and bone health.

[4]The eight calcium-rich foods consisted of milk as a beverage; milk with cereal; yogurt; cheese; mustard, turnip, or collard greens; canned salmon; calcium-fortified orange juice; and calcium-fortified cereals.

(2) Nonuse of calcium supplements—not taking a supplement with calcium. For the purposes of this study, a multivitamin supplement was *not* considered a calcium supplement.
(3) Nonuse of vitamin D-containing supplements—not taking any supplement containing vitamin D.
(4) Low physical activity—exercising less than 5 times/week and less than 150 minutes/week, regardless of intensity or type of exercise.
(5) High risk of falling at home—at least one of the following risks: not anchoring throw rugs, not having grab bars in bathroom, not having nonskid tape or nonskid mat in tub or shower area, or not turning on the light or using a night-light when getting out of bed at night.
(6) Current tobacco use.

Other items assessed were medication history, family history of osteoporosis and bone fractures, medical conditions, medications, illnesses, osteoporosis-related knowledge questions, menstruation history, and results from an orientation-memory-concentration (i.e., cognition) test. A panel of nutrition and pharmacy experts reviewed the questionnaire to increase face validity; modifications were made based on their recommendations. To help determine the reliability of the questionnaire for this population, we administered it twice to the same participants both before and after the intervention.

Participants were given a test to determine whether cognition was related to scores for modifiable osteoporosis-related risk factors. The cognition measure is a validated 6-item tool that discriminates cognitive function as being normal or minimally impaired (score of 8 or less), moderately impaired (9 to 19), or severely impaired (20 or more) (Katzman et al.,

Table 1. Baseline assessments of heel bone mineral density, T-score, and osteoporosis: Adults in the Older Americans Nutrition Program

	Total sample	Men	Women	Caucasian women	African-American women
Sample size	70	7	63	42	21
			Mean		
Heel BMD	0.47	0.51	0.46	0.45	0.49
T-score	-1.03	0.67	-1.07	-1.20	-0.83
			Percent		
Osteoporosis risk					
Low risk[1]	23	29	22	17	33
Moderate risk[2]	17	29	16	17	14
High risk[3]	60	43	62	67	52

[1]T-score > 0.
[2]T-score ≤ 0 and > -1.0.
[3]T-score ≤ -1.0.
Notes: Percentages may not add to 100 percent because of rounding. Data were not statistically associated with gender or ethnicity.

1983). Trained staff from the University of Georgia's Department of Foods and Nutrition read the questions to the participants and recorded their responses. During the interview, the trained staff used food models to help the participants determine portion sizes and give a more accurate estimate of the amount of calcium- and vitamin D-rich foods they consumed.

Statistical Analysis

To ensure consistency in coding, only one person coded all questionnaires. After coded data were entered twice in two different files, discrepancies were corrected to reflect the participants' responses. Baseline and post-intervention data were compared by using Chi-square analyses and paired *t*-tests to determine the statistical significance of changes in risk factors and other variables of interest; regression analyses were used to identify possible predictors of changes in risk factors scores.

Results

Of the 71 participants who enrolled at baseline, 70 had their heel BMD assessed, and 59 completed the intervention and the post-intervention questions. Of those who did not complete the post-intervention questions, 5 were out of town, 4 stopped going to the senior center, 1 was not a regular senior center participant, 1 refused to complete the questionnaire, and 1 died. Among the 59 participants who completed the post-intervention questions, 10 percent attended no lessons, 25 percent attended one lesson, 29 percent attended two lessons, and 36 percent attended all three lessons. The demographic characteristics of the attendees and non-attendees reflected those of the overall sample (77 years old, 90 to 93 percent female, 66 percent Caucasian, and 34 percent African American).

The mean BMI for these groups was 29.2 (data not shown). According to Government guidelines, a BMI of 29.2 is on the cusp of being overweight (BMI = 25 to 30) or obese (BMI greater than 30) (USDA & DHHS, 2000). Based on the BMD T-score, 60 percent of participants had either osteopenia or osteoporosis, 17 percent had moderate risk for a future bone fracture; 23 percent, a low risk (table 1). These measures, however, were not significantly associated with gender or ethnicity.

At baseline, all participants had at least one of the six modifiable osteoporosis-related risk factors (table 2). The most prevalent was low intake of calcium-rich foods (86 percent), and the least prevalent was current tobacco use (17 percent). At baseline, the various indices of risk factors were not significantly different between the total sample and the subgroup that completed the intervention. After the intervention, the total risk factors score (3.4), consumption of less than 3 servings of eight calcium-rich foods daily (69 percent), and non-use of calcium supplements (53 percent) significantly decreased; more than half (52 percent) of the participants reduced one or more risk factors. Although

Table 2. Baseline and post-intervention prevalence of modifiable osteoporosis-related risk factors: Adults in the Older Americans Nutrition Program

	Baseline, total sample	Baseline, completed intervention	Post-intervention
Sample size	71	59	59
		Mean	
Number of risk factors*	4.0	4.2	3.4
Weekly frequency of exercise*	4.2	4.6	5.4
		Percent	
Low intake of calcium-rich foods[1]*	86	88	69
Non-use of a calcium supplements*	77	83	53
Non-use of a vitamin D-containing supplements	65	68	54
Low physical activity[2]	83	85	80
High risk of falling at home[3]	75	78	71
Current tobacco use	17	17	12
Number of risk factors*			
0	0	0	0
1	6	3	12
2	8	7	10
3	15	14	34
4	28	29	17
5	32	40	25
6	10	8	2
5 or more risk factors	42	48	27

[1]Less than 3 servings per day.
[2]Less than 5 times per week and less than 150 minutes per week.
[3]Equal to or greater than one of four risks for falling.
* Statistically significant difference between baseline and post-intervention at p = .05.
Note: Percentages may not add to 100 percent because of rounding.

The major findings at baseline were that a substantial number of participants had osteopenia or osteoporosis based on their heel BMD results. After the intervention, participants significantly decreased their osteoporosis-related risk factors score and were more likely both to consume calcium-rich foods and to use calcium supplements.

there was no change in exercise risk after the intervention, more than half (55 percent) of participants reported doing the balance exercises at home (table 3), and the frequency of exercise increased significantly by about 1 time per week (from 4.6 to 5.4 times per week) (table 2). In a multivariate stepwise regression model, change in risk factors score was not significantly associated with age, gender, ethnicity, attendance at lessons, cognition, or whether participants had been told by their doctor that they had osteoporosis (data not shown).

We also explored ethnic differences between Caucasian and African-American women at baseline; there were too few men to make comparisons by gender. Compared with Caucasian women, African-American women had a significantly higher BMI (31.3 vs. 28.2) and were more likely to exercise less than 5 times per week and for less than 150 minutes per week (100 vs. 79 percent) (table 4). African-American women were also significantly more likely than Caucasian women not to use supplements: calcium (95 vs. 67 percent) or vitamin D-containing (86 vs. 50 percent). Thus, African-American women had significantly

more risk factors than did Caucasian women (4.7 vs. 3.9).

After the intervention, participants were asked whether they had made any changes related to osteoporosis risk since attending the educational lessons (table 3). Four of 10 reported that they had talked with their doctor about issues such as their heel BMD results and osteoporosis (41 percent each), a quarter had discussed prescription medications for osteoporosis, and about a quarter had discussed exercises for their bone health. A large number of participants increased their physical activity, practiced the balance exercises at home, and adopted at least one fall-prevention measure. Additionally, there were substantial increases in diet and supplement use, including eating more calcium-rich and calcium-fortified foods, and starting to take supplements with either calcium or vitamin D. Despite a detailed discussion of low-lactose dairy foods, very few participants started using commercially available low-lactose milk (5 percent) or tried using lactase tablets or drops (2 percent).

Table 3. Self-reported post-intervention changes related to modifiable osteoporosis-related risk factors: Adults in the Older Americans Nutrition Program

	Percent reporting risk factor
Talked with doctor about	
BMD results	41
Osteoporosis	41
Prescription medications for osteoporosis	25
Exercises for bone health	27
Increased physical activity	39
Practiced balance exercises at home	55
Adopted at least one fall-prevention measure	34
Dietary and supplement changes	
Ate more calcium-rich foods	30
Ate more calcium-fortified foods	20
Started taking calcium supplement	23
Started taking vitamin D supplement	11
Changed to low-lactose milk	5
Tried lactase tablets or drops	2

Note: n=59.

Discussion

The nutrition and bone health curriculum that was designed for low-literacy, low-income older adults reduced the number of modifiable osteoporosis-related risk factors and was associated with other self-reported behavioral changes. The major findings at baseline were that a substantial number of participants had osteopenia or osteoporosis based on their heel BMD results. After the intervention, participants significantly decreased their osteoporosis-related risk factors score and were more likely both to consume calcium-rich foods and to use calcium supplements. However, the consumption of calcium-rich foods increased by a statistically significant, but nutritionally small amount (2.5 servings/week), translating to minor increases in daily calcium intake.

There is a heightened awareness that African-American women are at risk for osteoporosis (Bohannon, 1999). Even though the mean heel BMD of women did not differ by ethnicity, it is possible that, compared with the Caucasian women, the African-American women in this study may be at somewhat higher future risk for osteoporosis for two reasons: they were less likely to take a calcium supplement or any vitamin D-containing supplement, and they were more likely to have signs of lactose intolerance. However, our sample size was small, and it is not possible to reach a definitive conclusion on ethnic differences in the osteoporosis-risk profile of these participants.

In addition to small sample size, there were other limitations in this study. The curriculum may not have accommodated varied levels of comprehension among the participants. Although we did not assess the educational level of this sample, we have found that the mean level of education is eighth grade in older adults receiving congregate meals from this same Area Agency on Aging (Brackett, 1999). To address concerns associated with comprehension, the educators reviewed and modified the curriculum before it was implemented. A question-and-answer period was included at the end of every lesson to allow participants to have their questions answered and to address issues that were not covered in the lessons. Also, not everyone attended all the lessons. To minimize the effect of absenteeism on behavior modification, instructors gave participants handouts that repeated important concepts and emphasized self-empowerment.

Table 4. Ethnic differences between Caucasian and African-American women at baseline: Adults in the Older Americans Nutrition Program

	Caucasian women	African-American women
Sample size	42	22
	Mean	
Age	76	76
BMI*	28.2	31.3
	Percent	
Osteoporosis-related risk factors		
Low intake of calcium-rich foods[1]	86	95
Non-use of calcium supplements*	67	95
Non-use of vitamin D-containing supplements*	50	86
Low physical activity[2]*	79	100
High risk of falling at home[3]	83	63
Current tobacco use	12	23
Mean number of risk factors*	3.9	4.7

[1]Less than 3 servings per day.
[2]Less than 5 times per week and less than 150 minutes per week.
[3]Equal to or greater than one of four risks for falling.
*Statistically significant difference between Caucasian and African-American women, at p = .05.

As in most behavioral change studies, another limitation was that the behavioral changes were self-reported. Objective biological measures of nutrition and bone health were beyond the scope of this study but would be important for future study. Future studies are needed to determine the long-term effect of educational interventions and behavioral changes on osteoporosis, bone mass, and incidence of bone fractures in older adults. Based on the limitations of this study, interpretation of the findings should not be applied to all Older Americans Nutrition Program participants, but can be used in planning, implementing, and evaluating similar future studies.

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